REMARKS

Reconsideration and allowance of this application, as amended, are respectfully requested. The written description and claims 1, 2, 4, 8, 15, 16, and 23-30 have been amended. Independent claim 31 has been added. Claims 1, 2, 4-10, 15-19, and 22-31 are now pending in the application. The rejections are respectfully submitted to be obviated in view of the amendments and remarks presented herein.

Applicants and Applicants' attorney acknowledge with gratitude the courtesies extended by the Examiner and Mr. Lee during the personal interview of August 7, 2003. The Interview Summary indicates that "[i]t was agreed that amending the Claims as follows would overcome the Keese reference." The Examiner suggested the claims be amended to include: "(1) a detailed description of image deviation amount in terms of both x, and y alignment conditions obtained simultaneously, (2) a detailed description of x, y slope calculation to determine image deviation direction."

Since the Interview Summary was prepared by the Examiner after the interview and transmitted to Applicants' attorney by facsimile later that day, Applicants did not have an opportunity to review the Interview Summary prior to its issuance. Therefore, Applicants comment as follows with regard to the statement in the Interview Summary that "both x, and y alignment conditions [be] obtained simultaneously." Such an amendment would unnecessarily limit the scope of the claims for the following important reason. In Applicants' claimed method, it is *not* necessary that the x and y alignment conditions be "obtained simultaneously." Instead, the x and y alignment conditions can, for example, be detected sequentially, but then the detected values are *used* together to determine the deviation in the sample images. As explained in more detail below, the

recitation of "two dimensional" deviations has been added to clarify that the detected x and y deviation values are *used* together in the calculation step that determines the claimed "relation of an alignment condition and deviation of the sample images." That is, by virtue of the definition of "two dimensional," a "two dimensional" deviation accounts for deviation in both the x and the y directions. In summary, although Applicants' x and y alignment conditions need *not* be *obtained* simultaneously, the detected values are *used* together to determine the deviation in the sample images.

In the present Amendment, the written description has been editorially amended for improved readability at page 12, lines 6-26. No issue of new matter is associated with the amendment.

Claims 1, 2, 4, 8, 15, and 16 have been amended to even more clearly define important features of the claimed method and apparatus. For example, claim 1 has been amended to define a charged particle beam alignment method that includes, *inter alia,* "calculating an unknown changing depending on a condition of said charged particle beam optical apparatus by applying information of the first and second two dimensional deviations to an equation indicating the relation of an alignment condition and deviation of the sample images." Support for claim 1 is found, for example, at specification page 11, equation 4. The recitation of "two dimensional" deviations has been added (in claim 1 and in other claims) to clarify that the detected x and y deviation values are *used* together in the calculation step that determines the claimed "relation of an alignment condition and deviation of the sample images." That is, by virtue of the definition of "two dimensional," a "two dimensional" deviation accounts for deviation in both the x and the y directions.

Independent claim 31 has been added to enhance the scope of protection sought for the invention, and claims 23 and 25-30 have been editorially amended so as to depend from claim 31. Entry of each of the amendments is respectfully requested.

Claims 1, 2, 4-10, 15-19, and 22-30 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,627,373 to Keese, in view of U.S. Patent No. 6,333,510 to Watanabe et al.[1] With regard to claims 1 and 24, the Office Action asserts that "utilization of computer 40 to automatically correct beam alignment and beam astigmatism in accordance with Keese (373) above, is equivalent to 'obtaining the alignment condition based on the calculated unknown and a condition in which an image deviation becomes small when the convergence condition of the objective lens is changed to the two condition.'"

The rejection is respectfully traversed. The Office Action has failed to establish a *prima facie* case of obviousness because all of the claimed limitations are not taught or suggested by the applied prior art references. Specifically, the asserted combination fails to teach or suggest, *inter alia*, the claimed features of "calculating an unknown changing depending on a condition of said charged particle beam optical apparatus by applying information of the first and second two dimensional deviations to an equation indicating the relation of an alignment condition and deviation of the sample images" (claim 1), or "calculating a coefficient indicating a relationship between a signal supplied to said alignment deflector and the two dimensional deviation between said images" (claim 24).

[1] Applicants' attorney notes that since Watanabe is not applied in the present Office Action, the examiner apparently intended to formulate a rejection over Keese in view of U.S. Patent No. 5,659,172 to Wagner et al. (hereinafter "Wagner"). Wagner is applied as a secondary reference at Office Action page 8.

Differences between the asserted combination and other claimed embodiments of Applicants' invention are outlined below.

As indicated above, claim 1 has been amended to define a charged particle beam alignment method that includes, *inter alia*, "calculating an unknown changing depending on a condition of said charged particle beam optical apparatus by applying information of the first and second two dimensional deviations to an equation indicating the relation of an alignment condition and deviation of the sample images." Claim 1 has been amended to clarify that in the present invention, an unknown that varies depending on the condition of the apparatus is calculated from an equation indicating the relation between the alignment condition (WAL') and the deviation (ΔWi). (See equation (4) at specification page 11.) According to Applicants' invention, the alignment condition that would minimize (ideally to zero) the parallax ΔWi that is produced when the object lens is set at two conditions is determined after calculating the unknown. In this way, a condition that is not dependent on the condition of the charged particle optical system can be attained.

Depending on the condition of the charged particle beam optical system, the actual alignment value may vary with respect to a predetermined alignment signal. Thus, in order to obtain a condition that does not depend on the charged particle beam optical system, it is necessary to calculate the condition of the aligner, and then determine a condition such that the parallax ΔWi can be minimized under that condition. This requirement is defined by the present invention.

Keese, however, fails to either teach or suggest anything related to Applicants' above-described calculating step. Attached hereto are two diagrams that further illustrate some of the differences between Applicants' claimed invention and the device of Keese.

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Keese merely discloses that control circuit 50 automatically carries out beam alignment (column 5, lines 24-54), and that the alignment is repeated until no translation of a straight edge at two extreme focus points is detected (column 2, lines 59-67).

Thus, Keese merely discloses the detection of sample image displacement that occurs when the objective lens condition is changed, and the adjustment of the aligner for eliminating the displacement, which are the prerequisite of the present invention. Therefore, Keese merely discloses that the beam *is aligned in a first and a second direction*, but without specifically describing *how* the alignment signal is calculated, as claimed.

More specifically, the Examiner's attention is directed to Keese's disclosure at column 6, line 31, through column 7, line 30 (entitled "Electron Beam Alignment"), and associated FIGS. 6-8. For example, at column 6, lines 42-44, Keese discloses that "[r]eferring to FIGS. 6 and 7, aperture 60 is first imaged along an axis that is substantially orthogonal to electron beam axis A_e. In this case, the axis is the y axis." Then, Keese discloses the following at column 7, lines 21-30:

> FIG. 7 shows an embodiment in which the Faraday cup is repositioned along x and y axes via stage 18 *to image a second position 68' on the aperture 60 edge which is 90 degrees offset from the first aperture point 68 imaged*. After repositioning, the edge is imaged. *FIG. 8 shows an image of the second sample edge. Such second sample edge is oriented along an axis orthogonal to both the first axis (e.g., the y axis) and the electron beam axis A_e.* In the case shown, the straight edge boundary portion 68 for the second sample is oriented along the x axis. The order of imaging an edge(s) along first and second orthogonal axes may vary. *The beam alignment process of detecting image translation and adjusting alignment as described above is repeated for the second sample image*

> and any subsequent sample images. *The alignment proceeds in an iterative manner taking images of edges at progressive 90° offsets.* The iterations stop when the difference in magnitude of the location indicator signals IND for extremes of focal range for a current sample image and previous sample image are less than a prescribed threshold improvement (emphasis added).

Thus, Keese teaches an iterative method of detecting a translation between images at two focus points (i.e., "images of edges at progressive 90° offsets," meaning, for example, first an image along the y axis, then an image along the x axis), and deflecting the electron beam in a certain direction. That is, according to Keese's method, the adjustment is not completed in a single alignment, but is instead, an iterative procedure. In contrast, in accordance with the present invention, alignment is carried out after unknown quantities that vary depending on the condition of the apparatus have been determined, so that the axial alignment can be performed by a single operation.

In Applicants' claimed invention, the condition of the aligner is calculated, and then a condition that would minimize (ideally to zero) ΔWi is determined. In so doing, highly accurate alignment can be performed while avoiding the trial and error process that is required in conventional methods such as that of Keese. Claim 1, therefore, is allowable over the asserted combination of references.

Claim 24 is also allowable over the cited references. The invention defined by claim 24 is similar to Keese only in that the deviation between sample images is detected when the optical element such as the objective lens is varied, and that axial adjustment is carried out using a condition such that the deviation become minimum. However, Keese neither teaches nor suggests calculating a coefficient indicating the relationship between

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the signal supplied to the alignment deflector and the two dimensional image deviation, as claimed.

Claim 2 is similarly allowable. Claim 2 defines a charged particle beam alignment method that includes the step of "calculating an unknown changing depending on a condition of said charged particle beam by applying information of the first and second two dimensional deviations to an equation indicating the relation of an alignment condition and deviation of the sample images." Thus, claim 2 is similar to claim 1, except that in claim 2 the objective lens recited in claim 1 is replaced with an astigmatism corrector as the object of the alignment. For reasons similar to those identified above with regard to the allowability of claim 1, Keese fails to either teach or suggest Applicants' claimed method that includes calculating an unknown based on the relation of an alignment condition and the two dimensional deviation of the sample images.

Claim 4 is similarly allowable. Claim 4 defines a charged particle beam apparatus that includes "a control device for calculating a coefficient indicating the deviation between said images with respect to a signal supplied to said alignment deflector based on said first and second two dimensional deviations, wherein the signal to be supplied to the alignment deflector is calculated using said coefficient such that the deviation between said images becomes zero or nearly zero." For reasons similar to those identified above with regard to the allowability of claims 1 and 24, Keese fails to either teach or suggest Applicants' claimed control device for calculating a coefficient indicating the two dimensional deviation between said images.

Claim 8 is also allowable. Claim 8 defines a charged particle beam apparatus that includes "a control device for calculating a coefficient indicating the two dimensional deviation between said images with respect to a signal supplied to said alignment deflector based on said first and second deviations, wherein the signal to be supplied to the alignment deflector is calculated using said coefficient such that the deviation between said images becomes zero or nearly zero." Thus, claim 8 is directed to an astigmatism corrector as the object of the alignment, as opposed to the lens of claim 4.

Claim 15 is also allowable. Claim 15 defines a charged particle beam alignment method that includes the step of "calculating a coefficient indicating the deviation between said images with respect to the signal supplied to said alignment deflector based on said first two dimensional deviation and said second two dimensional deviation, wherein an operation condition of the alignment deflector is determined using said coefficient such that the deviation between said images becomes zero or nearly zero." Therefore, the method defined by claim 15 is based on the above-described apparatus defined in claims 4 and 8.

Claim 16 is similarly allowable. Claim 16 defines an apparatus that includes "selection means for selecting whether a coefficient indicating the sensitivity of the alignment deflector should be recalculated based on a given indicator, or the operation condition of said alignment deflector should be determined using a coefficient that is stored in advance." As is evident from the reasons given above for the allowability of claim 1, a major difference between the method of Keese and Applicants' invention is that in Applicants' method, information (such as coefficients or unknown quantities) relating to the sensitivity of the alignment deflector is calculated, whereas in Keese, no such

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calculation is carried out. This distinction is important, because the deflection condition of the alignment deflector varies depending on the condition of the apparatus, and as time passes. Therefore, even if the translation between the first and second images formed at first and second points of the focal range of the objective lens was identical at different alignment timings, the signal necessary for the alignment may have varied.

According to claim 16, however, it is possible to select whether a coefficient indicating the deflection sensitivity should be calculated using a pre-arranged indicator, or whether axial adjustment should be performed without conducting a calculation process. By virtue of this feature of Applicants' invention, both high axial adjustment accuracy, and high processing speed, can be realized at the same time. Neither of the cited references either teaches or suggests the feature of calculating the sensitivity of the alignment deflector.

Claim 22 is also allowable. Claim 22 defines an apparatus that provides for (1) focus adjustment by the objective lens, (2) alignment of the astigmatism corrector disposed closer to the electron source than the objective lens, (3) alignment of the objective lens, and (4) astigmatism correction by an astigmatism corrector. Thus, claim 22 defines an apparatus that provides for the adjustment of the optical element, and adjustment of the axis. Initially, focus adjustment of the objective lens is carried out to obtain images that will be necessary for the subsequent axis adjustment while eliminating blurs. Then, alignment is carried out sequentially starting from the element closer to the electron source in order to eliminate the need to displace the optical axis that has once been aligned downstream (i.e., toward the side farther from the electron source).

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Thus, claim 22 defines the appropriate arrangement for the alignment of the objective lens and the astigmatism corrector, the focus adjustment, and the correction of astigmatism when they are carried out together. Because Keese merely discloses the alignment of the objective lens and the astigmatism corrector, and does not disclose the above-described features (1) to (4), the claimed invention is allowable over Keese.

Finally, with regard to claim 30, Wagner cannot compensate for any the above-described deficiencies of Keese. First, as indicated above, claim 30 has been amended to depend from new claim 31. Secondly, regardless of what Wagner may suggest with regard to a center of gravity reference point for image comparison, there is no teaching or suggestion whatsoever in Wagner of Applicant's apparatus as defined by claim 31, *and* "means for detecting centers of gravity in the patterns of two images obtained when the charged particle beam scans while changing a condition of the optical element; and means for calculating a deflection amount of the alignment deflector based on a deviation between the centers of gravity of the two patterns," as defined by claim 30.

For at least the above reasons, reconsideration and withdrawal of the rejection of claims 1, 2, 4-10, 15-19, and 22-30 under § 103(a) are respectfully requested.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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Respectfully submitted,

By [signature]

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